



Efficacy of emamectin benzoate in the control of *Caligus rogercresseyi* on farmed Atlantic salmon (*Salmo salar* L.) in Chile from 2006 to 2007

Sandra Bravo ^{a,*}, María T. Silva ^a, Gustavo Monti ^b

^a Aquaculture Institute, Universidad Austral de Chile, PO Box 1327, Puerto Montt, Chile

^b Institute of Preventive Medicine, Faculty of Veterinary Sciences, Universidad Austral de Chile, PO Box 567, Valdivia, Chile

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ABSTRACT

Caligus rogercresseyi (Boxshall and Bravo, 2000) has been one of the greatest challenges for the salmon farming industry in Chile since 1997. A field study was carried out in four areas of Region X in the period 2006–2007 to obtain information about the efficacy of emamectin benzoate in the control of *C. rogercresseyi* in farmed Atlantic salmon (*Salmo salar*), one of the susceptible salmon species reared in Chile. The results obtained in this study show that the differences observed in the values of prevalence and abundance between the four areas in Region X were mainly caused by the oceanographic conditions and not as a consequence of the number of treatments with emamectin benzoate applied in the period of study, which on average ranged between 8 and 14 treatments by area.

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1. Introduction

The salmon industry is one of the main economic activities of Chile, and *Caligus rogercresseyi* is one of the main threats to the salmon industry since 1997 (Boxshall and Bravo, 2000). In 2007, 71% of salmon were produced in the inland sea of Region X (41°46'S 72°56'W; 43°07'S 73°38'W), where the three main salmonids species are reared, Atlantic salmon (*Salmo salar*), coho salmon (*Oncorhynchus kisutch*) and rainbow trout (*Oncorhynchus mykiss*). The two susceptible salmonids species are Atlantic salmon and rainbow trout, and both salmonids species constitute approximately 80% of the salmon production in Chile, while coho salmon has been shown to be resistant to this louse (Bravo, 2003; Gonzalez et al., 2000; Pino-Marambio et al., 2007).

Since the first confirmed report of sea lice in Chile (Reyes and Bravo, 1983), several medicines have been used to keep *Caligus* under control. As in the northern hemisphere (Costello, 1993; Roth et al., 1993), bath treatments followed by oral treatments were initially used. Ivermectin administered in-feed was introduced in Chile at the end of the 1980's and it was used to control sea lice until 2003. At the end of the 1990's Slice® was introduced to the Chilean market and it was approved by the Chilean medicinal authority in 2000 as the only chemical parasiticide permitted for use in the control of sea lice (Bravo et al., 2008a, 2010). However, a year later, three additional generic emamectin benzoate (EMB) were available in the Chilean market at a lower price, which contributed to an increase in the use of this parasiticide in the period 2000–2007, reaching 1.5 g per ton of salmon produced in 2007 (Fig. 2).

Emamectin benzoate gave a protection of eight weeks in closed sites in the first five years (Fig. 3) and over three months in open sites (Fig. 3B), with reduction in the lice population of over 90% (challimus and adults). This was with a recommended dosage of 50 µg kg⁻¹ fish day⁻¹ administered for 7 consecutive days. This situation changed in 2005 when the treatments with EMB did not give the expected protection at the concentration and period recommended by the pharmaceutical companies. Which cause that the farmers increased the dose and the period of application because of the loss of the efficacy of the product, without success in the reduction of the load of lice per fish. The loss of sensitivity of *C. rogercresseyi* against EMB was later confirmed using the bioassays developed by Sevatdal and Horsberg (2003) to assess sensitivity in *Lepeophtheirus salmonis* against the pyrethroid deltamethrin, and modified for EMB assessment (Bravo et al., 2008a, 2008b). Throughout the application of the bioassays, a reduction of sensitivity of *C. rogercresseyi* to EMB was documented in four locations of the region X. In addition, it was documented that a reduction of sensitivity can persist for at least seven inbred generations of *C. rogercresseyi*, without being exposed to a selection pressure of EMB (Bravo et al., 2010).

After the evidence of resistance was recorded in *C. rogercresseyi* to EMB (Bravo et al., 2008a, 2010), Caligidosis was included into the List 2 of high risk diseases for salmonids in 2007, by the Competent Authority in Chile (Sernapesca), which allowed that other chemotherapeutic products to control *Caligus* were introduced into the Chilean market, to minimize the risk of resistance through the alternation of medicines.

The aim of this study was to document the effect of the location over the efficacy of the treatments applied with emamectin benzoate for delousing Atlantic salmon in the period 2006–2007 in the same four areas of Region X, where loss of sensitivity against EMB was reported (Fig. 1).

* Corresponding author. Tel.: +56 65 277121; fax: +56 65 255583.

E-mail address: sbravo@uach.cl (S. Bravo).

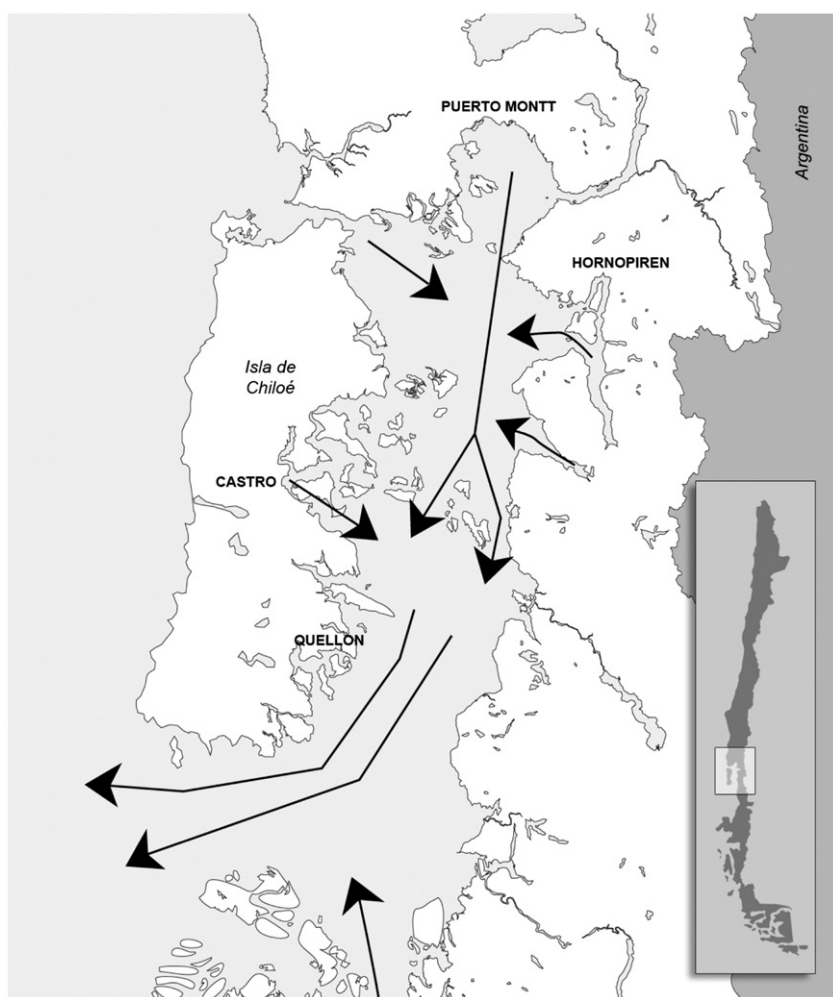


Fig. 1. Areas in Region X from which lice samples were collected throughout the study period. Arrows indicate the predominant directions of surface currents in Region X.

2. Material and methods

2.1. Area under study

The survey was carried out in four areas of the inland sea in the Region X, Chile, and each one with different geographic and oceanographic characteristics. For each area four farms were selected (Fig. 1):

- Puerto Montt ($41^{\circ}46'S$ $72^{\circ}56'W$);
- Hornopiren ($41^{\circ}52'S$ $72^{\circ}25'W$);

- Castro ($42^{\circ}40'S$ $73^{\circ}15'W$);
- Quellón ($43^{\circ}07'S$ $73^{\circ}38'W$).

The inland sea in Region X is bordered by Chiloé Island to the west, the mainland to the north and east and the Corcovado Gulf to the south. The aerial distance from Puerto Montt in the north to the southern end of Chiloé Island is approximately 220 km. At the mouth of the Corcovado Gulf the inland sea is approximately 50 km wide. The local system of currents is greatly influenced by the tide reaching up to 7 m. The predominant direction of the surface currents is from north to south (Fig. 1). Salmon farms are mainly located in sheltered water with a depth of up to 50 m. The speed of the currents usually ranges between 10 and 20 cm/s in 5 m deep surface water. However, the currents can reach a speed of up to 70 cm/s in narrow channels (Instituto Tecnológico del Salmón, 2007).

2.2. Sampling procedure

Three cages were selected per farm to assess the efficacy of EMB over *Caligus* infestation. These were stocked with a single year class of fish, one in the middle of the set of cages and one in each extreme of the set in each farm, and these were fixed for the whole period of study. Every second week 15 fish were randomly selected from each cage, for a period of 12 months. Staff involved in the survey from each farm were trained on lice monitoring to standardize procedures.

Fish were anesthetized with benzocaine (10% in ethanol, 1 ml L^{-1}) and each fish individually examined macroscopically. Lice were classified according to the sex and stage of development (female, male and

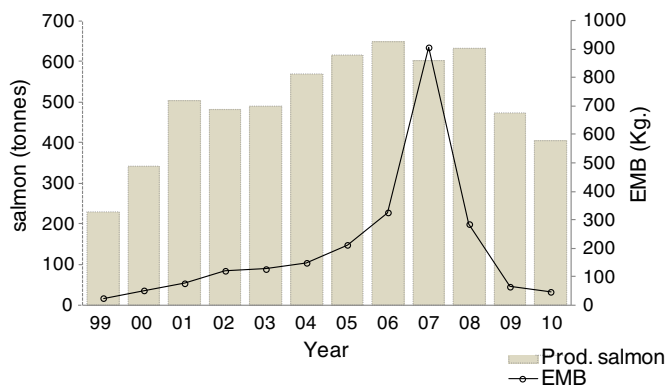


Fig. 2. Amount of emamectin benzoate (Kg) used in Chile for the control of *Caligus rogercresseyi* versus salmon production (ton). The data for the period 1999–2003 was obtained from the project FIP 2003–28; data from 2004 to 2007 was supplied by a pharmaceutical company and data from 2008 to 2010 was supplied by Sernapesca.

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